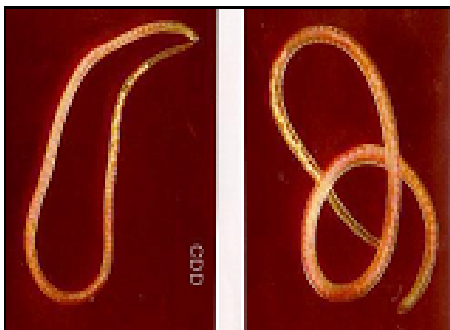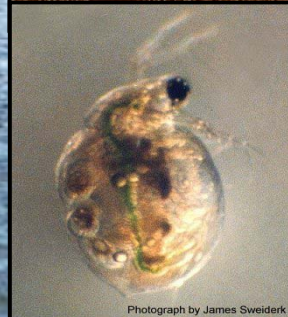# Ecological Risk Assessment for Benthic Invertebrates

Gary Lawrence (EVS Environment Consultants)

Assessment Endpoint and Representative Species

- Assessment Endpoint – community structure, survival, growth, and reproduction

- (1) "Whole" – examine entire benthic community assemblage

- (2) "Specific" – indicator test species:
  - *Chironomus tentans* (midge);
  - *Hyalella azteca* (amphipod);
  - *Daphnia magna, Ceriodaphnia dubia* (crustaceans);
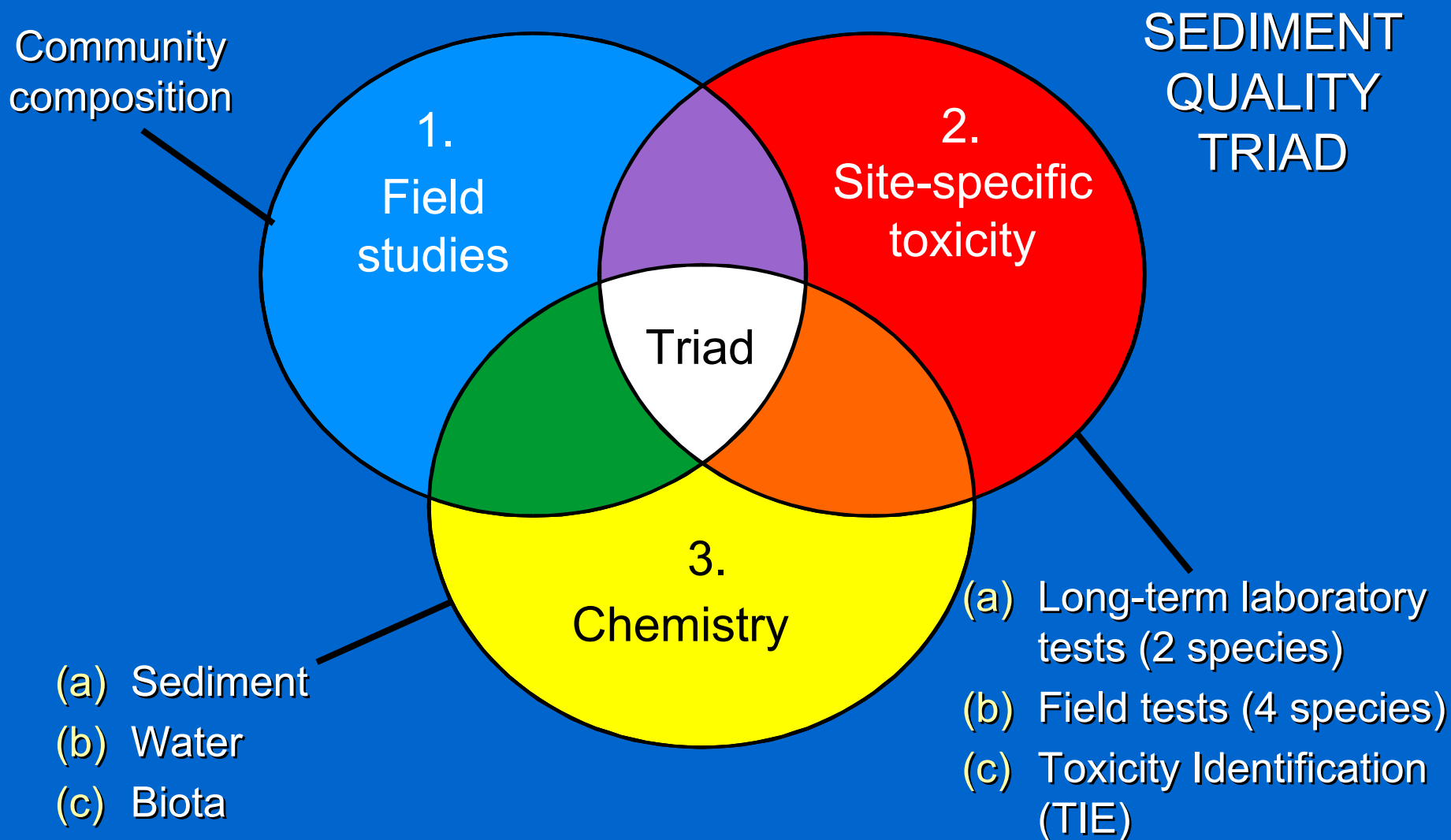 - *Lumbriculus variegatus* (worm)

Photograph by James Sweiderk

Measurement Endpoints and Lines of Evidence

Community composition

SEDIMENT QUALITY TRIAD

1. Field studies

2. Site-specific toxicity

Triad

3. Chemistry

(a) Sediment
(b) Water
(c) Biota

(a) Long-term laboratory tests (2 species)
(b) Field tests (4 species)
(c) Toxicity Identification (TIE)

A2	River Mile: N/A
	HW-SE000161

A3	River Mile: N/A
	HW-SE000398

Reach 4

1	River Mile: 134.03
	H3-SE000051

A1	River Mile: 144
	H0-SEEC0011

2	River Mile: 133.79
	H3-SE000060

Reach 5A

4	River Mile: 132.34
	H3-SEEC0019

3	River Mile: 133.13
	H3-SD043702

5	River Mile: 130.32
	H3-SE000428

Reach 5B

6	River Mile: 128.7
	H3-SE000116

LEGEND:

▲ Benthic Community Stations Without Toxicity Testing

▲ Benthic Community Stations With Toxicity Testing

〜 Reach Breaks

〜 Roads

Hydrography

Housatonic River Basin Boundary

Notes: - Code in left box of each ID represents "simplified" nomenclature used for benthic invertebrate ERA.
- Station 8A was positioned 12 meters from Station 8, and was tested for laboratory toxicity only.

Reach 5C

7	River Mile: 126.38
	H3-SE000389

8A	River Mile: 125.65
	H3-SEEC0023

8	River Mile: 125.65
	H3-SEEC0031

Reach 5D
(back water areas)

9	River Mile: 124.5
	H3-SE000246

Woods Pond

Reach 6

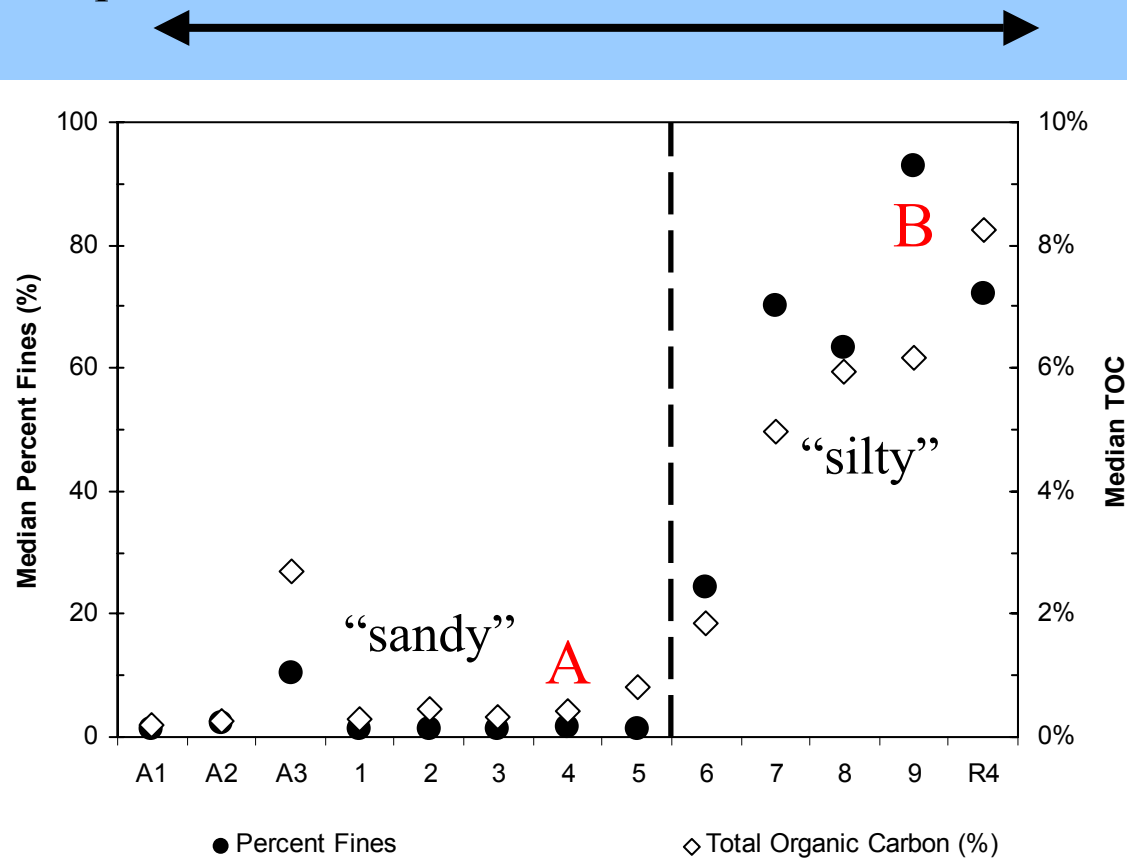|	
R4	River Mile: N/A
	H9-SE000615

Holmes Rd

New Lenox Rd

20

7

Exposure Assessment

- Biota tissue, water, and sediment data
- Contaminants of Concern from invertebrate-specific screening: PCBs, dioxins/furans, PAHs, and some metals
- PCBs are the dominant chemical stressor

Habitat/Substrate Change in Primary Study Area
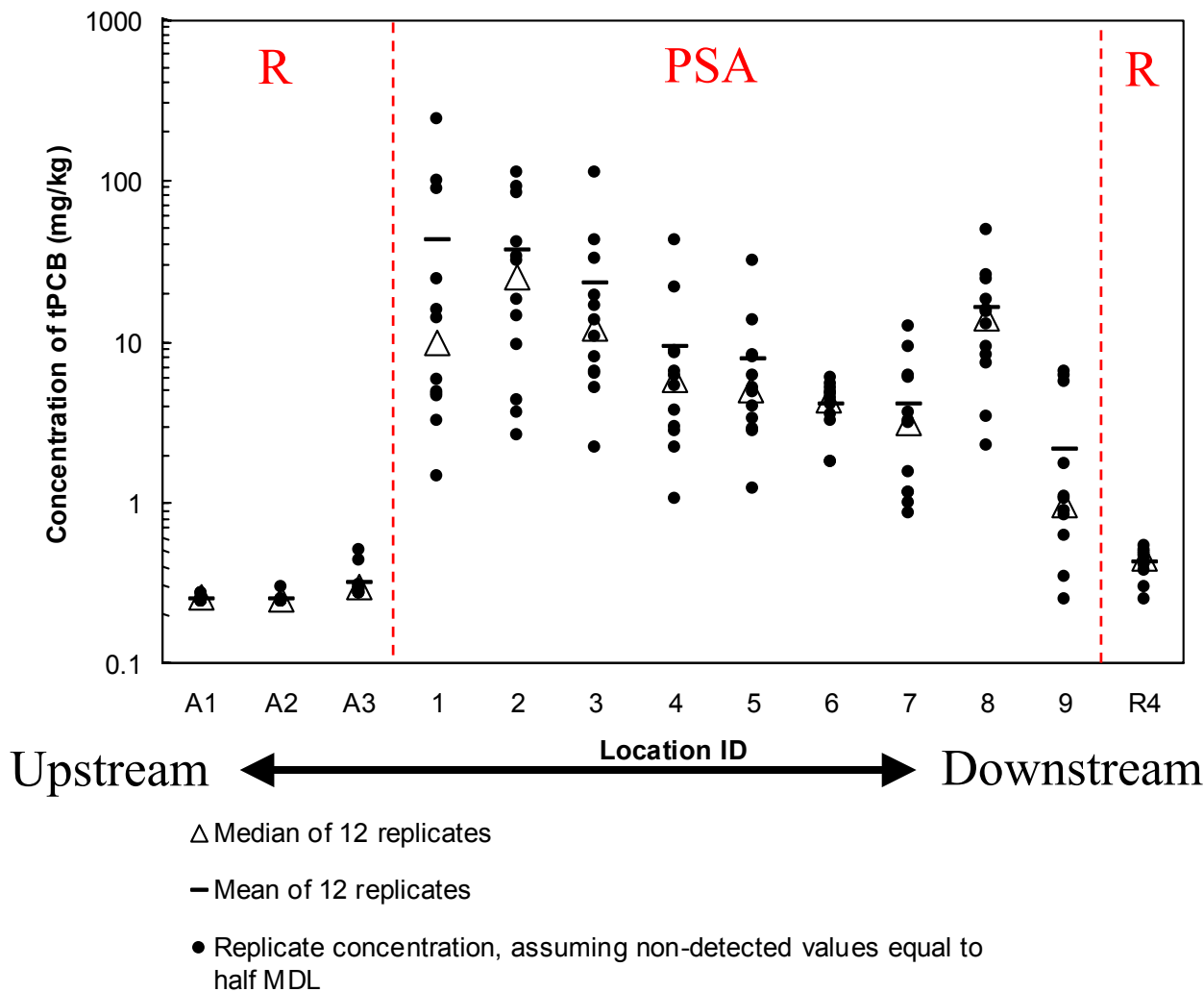

A - (1.5 mi below Holmes Rd.)

B - (Woods Pond Headwaters)

Sediment tPCB Concentrations in Benthic Community Samples (log scale)

- NOTE:
  - large variability
  - PSA elevated above references
  - gradient observed

△ Median of 12 replicates

– Mean of 12 replicates

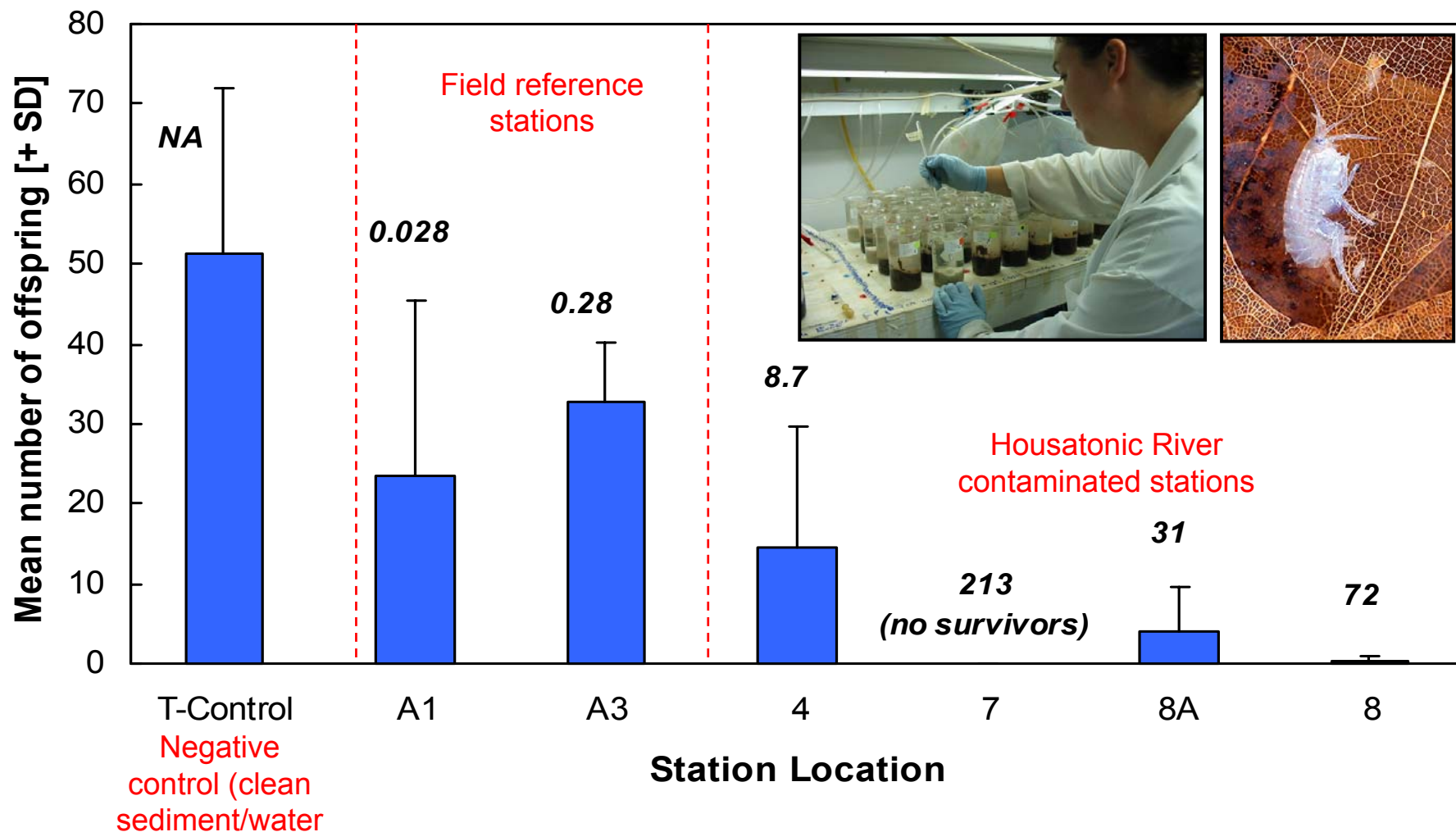● Replicate concentration, assuming non-detected values equal to half MDL

Effects Assessment - Methods

- Toxicity tests (laboratory, field, and TIE); Wright State University (Dr. G.A. Burton)
- Benthic community measures
- Literature reviews (sediment, tissue)
- Concentration-response evaluation

Laboratory *Hyalella* Toxicity (42-day Reproduction)

Field *Daphnia* Toxicity Survival (48-h Survival)

Graph: Mean Survival (%) [+ SD] vs Station Location

Sediment tPCB concentration (ppm) in italics

- Lab Control: *NA*, ~92%
- A1: *0.0001*, ~100%
- A3: *0.38*, ~87%
- 4: *0.95*, ~82%
- 5: *7.3*, ~48%
- 7: *139* (no survivors)
- 8: *522* (no survivors)

Field reference stations

Housatonic River contaminated stations
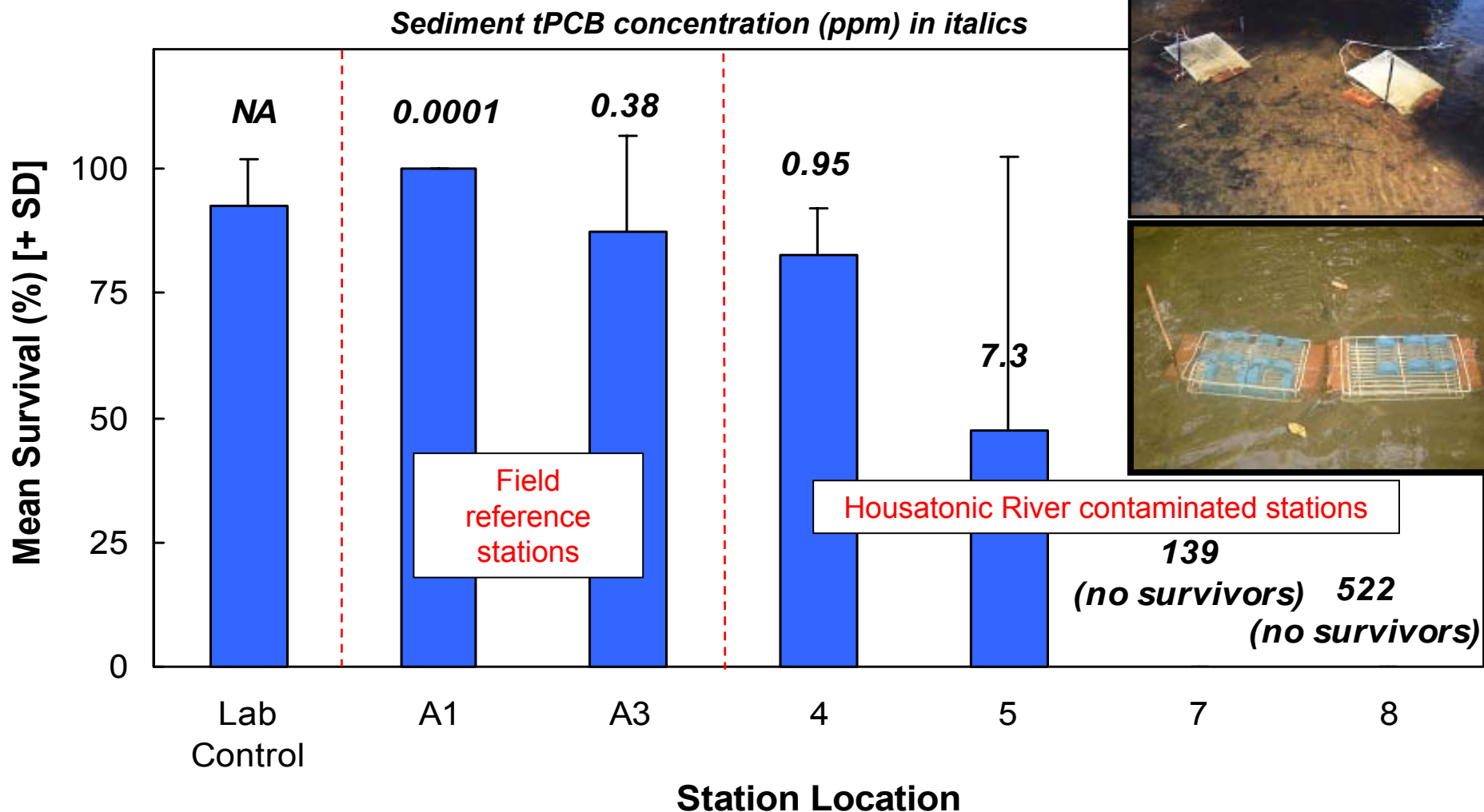
Toxicity Identification Evaluation (TIE)

- Wright State University. (USEPA protocols)

- *Ceriodaphnia dubia*

- Modified toxicity test conditions (treatments) and observed changes in toxicity

- Non-polar organics (PCBs, dioxins/furans, PAHs) identified as toxicant group

- Metals, others excluded

Photograph by James Sweiderk

Benthic Community Structure

- Taxonomy and PCB chemistry
- Investigated individual metrics (e.g., total abundance, species numbers) and combined metrics (multivariate methods)
- 12 replicates (individual grab samples) collected from each of 13 stations (8 "sandy" + 5 "silty")
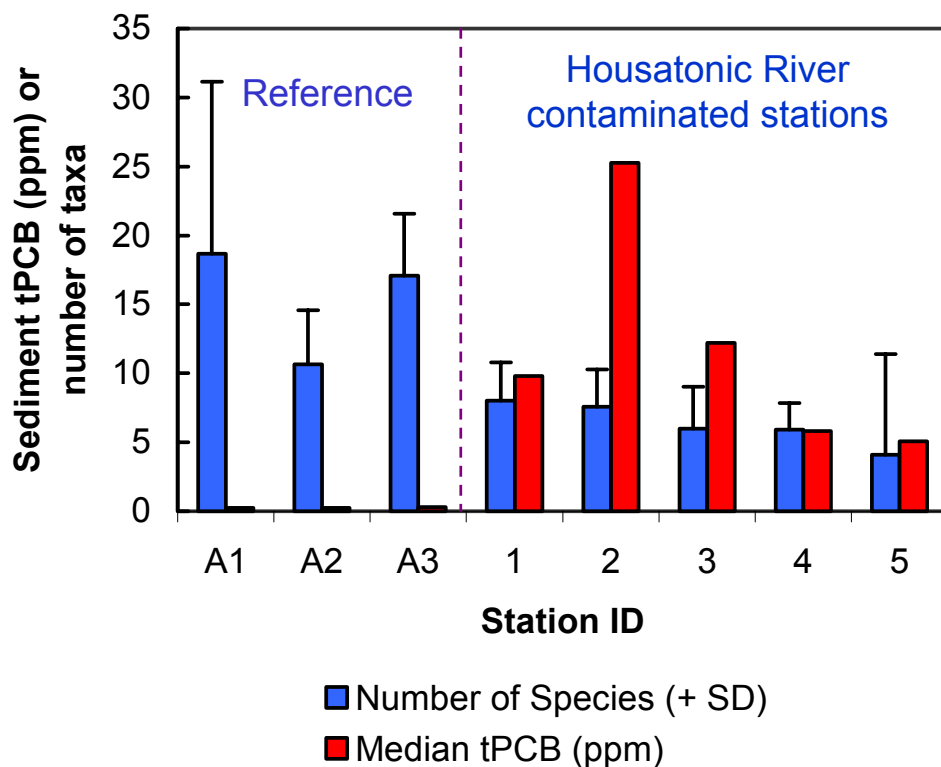
Benthic Community Structure – Taxonomic Richness
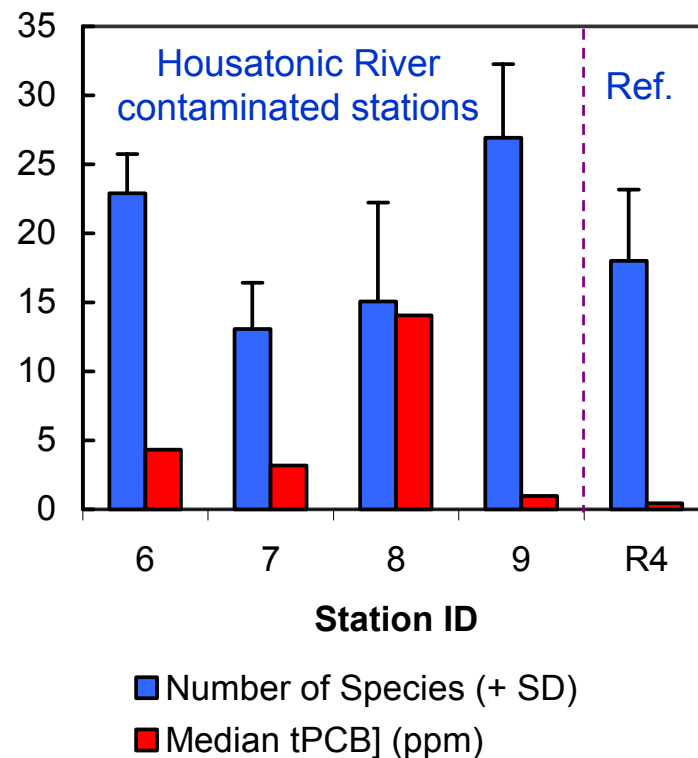
Effects Assessment - Chemistry

- Literature review of tPCB effects in tissue and sediment
- Concentration-response assessment for site-specific studies
- Good agreement between approaches
- Threshold level identified: 3 ppm tPCB

Risk Characterization – Lines of Evidence (continued)

Major Line of Evidence	Station ID									
	Coarse-Grained (Sandy)					Fine-Grained (Silty)				
	1	2	3	4	5	6	7	8A	8	9
Toxicity (11 endpoints)	-	-	-	◉	◉	-	●	●	●	-
Benthic Community (5 endpoints)	◉	◉	●	●	●	○	○	-	○	○
Chemistry (7 endpoints)	●	●	●	●	●	●	●	●	●	◉
OVERALL	●	●	●	●	●	◉	●	●	●	◉

● = major impact   ◉ = moderate impact   ○ = negligible impact

Risk Characterization

Measurement Endpoints	Weighting	Coarse-Grained Sediments	
		Evidence of Harm	Magnitude
C. Chemical Measures			
C-1. Water chemisty	Low/ Mod	Yes	Intermediate
C-2. Sediment chemistry	Low/ Mod	Yes	High
C-3. Tissue chemistry	Moderate	Yes	Intermediate
T. Toxicological Measures			
T-1. Sediment toxicity (laboratory)	Mod/ High	Yes	High
T-2. Sediment toxicity (field)	Mod/ High	Yes	Intermediate
T-3. Indications of PCB as toxicity driver in TIE	Moderate	Yes	High
B. Benthic Community Measures			
B-1. Abundance, richness, and biomass of invertebrates, relative to reference	Moderate	Yes	Intermediate
B-2. Benthic community structure, using multivariate assessment	Moderate	Yes	Intermediate
B-3. Modified Hilsenhoff Biotic Index (MHBI) indicator of organic pollution	Moderate	No	—

Summary of Risks
(By Reach)
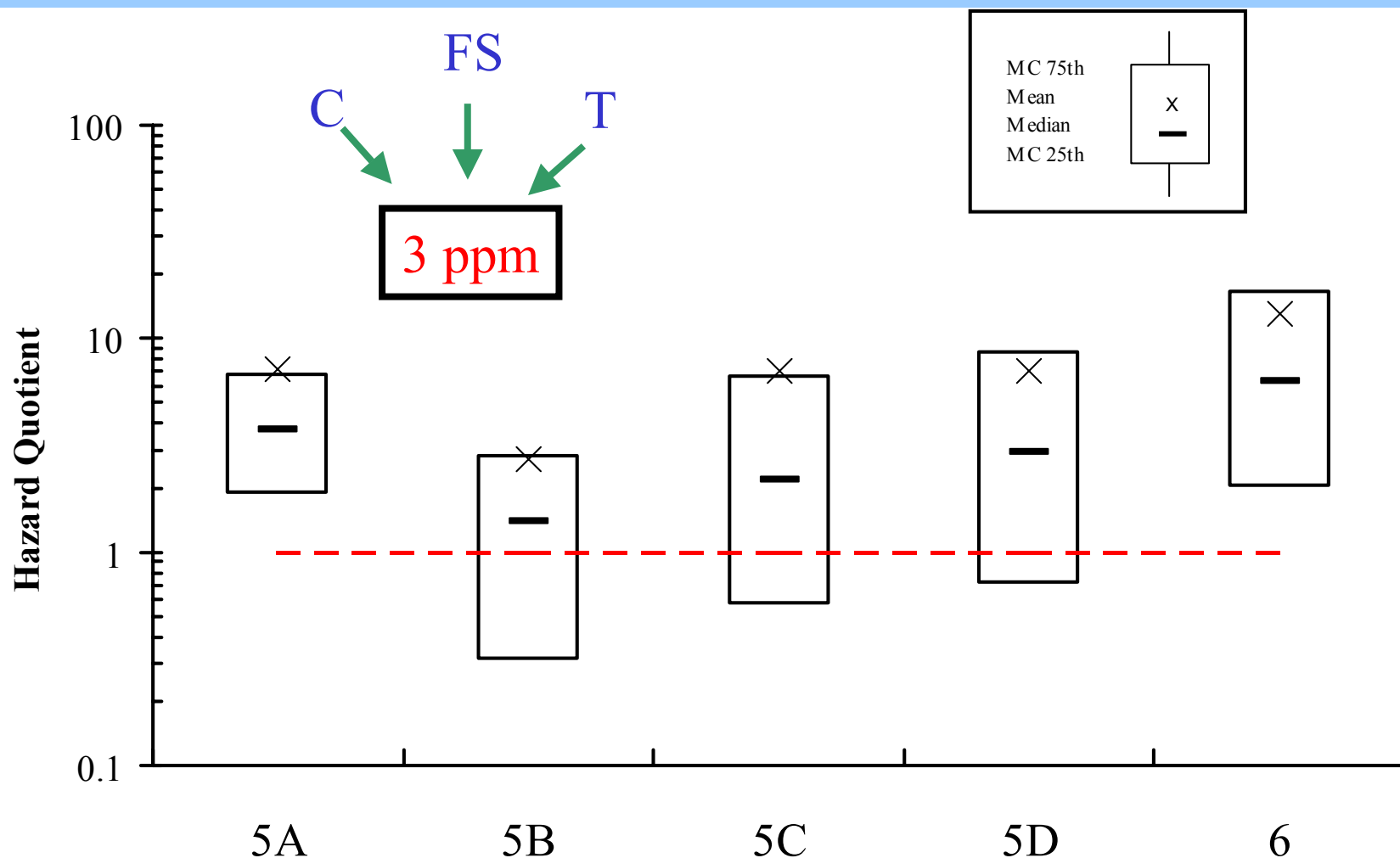
Extrapolation of Risks

- No extrapolation to other species necessary

- Risks reduced downstream of Woods Pond

- Risks negligible below Great Barrington (PCB < 3 ppm)